METHOD FOR TESTING CONTAINERS, USE OF THE METHOD, AND A TESTING DEVICE

This invention pertains to a method as described in the preamble to claim 1, uses of this method according to claim 9 or 10, a testing device as described in the preamble to claim 11, and use of said device according to claim 19.

This invention pertains to a testing device such as is known from US-PS 5,029,464 and EP-A-O 313 678 and EP-A-O 432 143.

From these items a way is known that a pressure differential is to be created between a pressure in the interior of the container and a pressure in said container's environment in order to test the gas tightness of containers and, from the behavior of one of the pressures, it is to be established whether the container under test satisfies the gas-tightness conditions or volume conditions or not.

In this process the container to be tested is placed in a sealing chamber that is connected to a pressure medium source or a suction source; said arrangement is to be used to create the above-mentioned pressure differential. After the pressure differential is created, a pressure value for the environment of the container is stored as a starting condition in a reference pressure chamber, which is placed in front of a pressure differential sensor, and is compared with subsequent pressure values for the environment of the container.

The above-mentioned documents are thus declared to be an integral part of the present description.

A drawback to the known method is the fact that a pressure differential sensor with extremely accurate control valves must be provided to ensure that even very small leaks or slight deviations of the container volume from a nominal volume are detected.

The goal set for the present invention is to simplify this known method significantly. The method of the invention as described by the text of claim 1 and the corresponding arrangement as described by that of claim 11 are exceptionally well suited for accomplishing this goal.

Accordingly, a pressure differential sensor is no longer used, nor are pneumatic storage chambers; instead, the pressure that is of interest is determined by means of a relative-pressure sensor and converted into an electrical signal; when checking for leaks, this signal is stored at a predetermined time and compared with at least one subsequent value that is determined by this same sensor. When checking volume, a pressure value is pre-specified and stored as a basis for comparison. This obviates the need for awkward devices of the previously known type, namely the pressure differential sensor and, in particular, the stop valves that are quite difficult as regards control characteristics.

The method of the invention is implemented in a configuration that is specified in claims 3-6.

The preferable procedure is indicated by the text of claim 3 or claim 6, wherein both the source connection to admit the pressure medium or to ensure suction and the sensor input are hooked up to either the interior of the container or the container's environment.

The creation of the pressure differential can be done in different ways, with which the specialist is well acquainted from the above-mentioned documents. Thus, for example, the pressure differential can be created by carrying out pressurization or suction at a predetermined level for a predetermined time, and then analyzing both a pressure value that is reached and its plot. In addition, pressurization can be done to a predetermined pressure differential, and then the plot of the pressure value that is of interest can be observed.

As is known from the above-mentioned documents, pressurization can also be accomplished by precharging a pre-chamber to a predetermined pressure and then discharging said chamber into the container or into an enclosure that is formed by a sealable chamber.

When checking volume, a volume that is dependent on the volume of the container, either the interior volume of said container itself or its volume differential compared to a testing chamber, can be pressurized by a predetermined quantity of pressure medium, or a predetermined amount of gas can be removed from this volume. The volume of the container is then determined from the resulting pressure.

Of course, the values that are measured are compared with nominal values or nominal plots, as is also know from the abov - mentioned documents.

Storage, as described by the text of claim 7, is preferably undertaken in such a way that, with control at a predetermined time, an analog/digital converter is enabled to convert the sensor output signal, and the then stationary output signal of this analog/digital converter is used as a reference value for the subsequent analysis of the sensor output signal. In this process, either another analog/digital converter can be installed behind the sensor output and the output signal of the latter converter can then be digitally compared to that of the storage unit A/D converter or, preferably, a D/A converter is placed immediately behind the storage A/D converter and thus the stored, re-converted signal is fed as an analog reference signal to an analog comparator unit, to which the output signal of the sensor is also fed directly.

In addition, and as described by the text of claim 8, a null balance is preferably undertaken by determining, essentially during the value storage process at the comparator, whether an output signal of the device encompasses the null value, at least approximately; if a signal appears that deviates from the null value or from a predetermined minimum value, then said signal is used as a null-balance signal.

Preferred embodiments of the device of the invention are specified in claims 12-18.

The invention is hereinafter explained by way of examples, using figures.

Here:

Fig. 1   shows a schematic of an arrangement of the invention, in which the pressurization source and suction source are connected to the environment of the container;

Fig. 2   shows a schematic, as per Fig. 1, of a section of the system as shown in Fig. 1, in another embodiment;

Fig. 3   similar to Fig 2, shows the section of a third embodiment;

Fig. 4   similar to Fig 2, shows the section of another preferred embodiment;

Fig. 5   shows a functional block diagram of a preferred arrangement as described by the invention for implementing a test method of the invention;

Fig. 6   provides a purely schematic illustration of the plot of a measurement curve.

As mentioned, Fig. 1 schematically depicts a closed container 1 that is to be checked for leaks or to determine its volume; said container may, for example, be already filled and be in a testing chamber 3. Chamber 3 can be sealed by means of, for example, insert cover 5. Via a controlled valve 7, the test volume, here the volume differential between chamber 3 and container 1, is pressurized by means of a suction or pressure source 9 in such a way that a pressure gradient is created across the walls of container 1. In this embodiment, source 9 empties into chamber 3.

At or in chamber 3 is another relative-pressure sensor 11, which converts the input-side pressure value into an electrical output signal. Via a storage control circuit, as indicated in the schematic by S, electrical output signal el from sensor 11 is stored in a storage unit 13 in response to a control signal s that is emitted by a time control unit (not shown). Output signal el_o from storage unit 13 is fed to a comparator unit 15 as a pressure reference value. Output signal el of sensor 11 is present directly at said comparator unit's second input. After reference value el_o is stored, the plot of the pressure in chamber 3 is monitored at comparator unit 15.

Let us now first consider leakage testing. If container 1 is sealed and storage has been done in storage unit 13, then sensor output signal el will remain at stored value el_o once all differential-induced shape changes in container 1 have subsided. On the output side of comparator 15, a comparison result that at least approximately equals zero indicates that container 1 is sealed.

If leaks are present in container 1, after reference value el_o is stored as mentioned signal value el will vary depending on the direction of the pressure gradient across the container wall; the higher the rate of variation, the larger the leak.

Comparing the output signal of comparator unit 15 with predetermined nominal values (not shown) provides an indication, on the one hand, as to whether a leak is present as well as, on the other, as to how large said leak is. Depending on the containers to be tested, minor leaks may be tolerated.

If the leak in container 1 is large, then absolutely no pressure differential will develop across the walls of container 1: the pressures between the interior of the container and its environment will quickly equalize via the leak. Then, however, on the output side of comparator 15 a null signal will appear, i.e., just as in the case of a sealed container, and lead to testing errors.

Therefore, as indicated by the dotted lines, preferably after value el_o is stored in storage unit 13, this stored value is compared to a reference value ref at another comparator unit 17. The output signal of other comparator unit 17 indicates whether a large leak is present or not. Either when a predetermined amount of pressure medium is allowed to enter chamber 3 or when a predetermined amount of gas is removed from said chamber, in the case of a large leak the pressure value indicated by reference value ref will not be reached; this will cause the test result at container 1 to be indicated by the output signal of other comparator 17.

To test volume, a predetermined amount of pressure medium is fed to chamber 3 or a predetermined amount of gas is removed therefrom. As indicated by dotted lines at ref_1, storage unit 13 is used here as a reference-value storage unit in which reference values corresponding to the nominal volumes of containers that are to be tested are prestored. By comparing above-mentioned volume reference values ref, and the pressure value that actually arises corresponding to el in the volume differential in chamber 3 that is dependent on the interior volume of container 1, i.e.,

from the output signal of comparator unit 15, a determination is made as to whether container 1 has nominal volume or not, or how large the nominal/actual volume differential is.

In the case of the embodiment shown in Fig. 2, where the references used in Fig. 1 are used for the same parts, only source 9 empties into chamber 3. Via a sealed closure 19, the input of sensor 11 is connected to the interior of container 1 that is fitted with an opening. The electronic analyzer, which is placed behind sensor 11, is depicted just as in Fig. 1.

As in Fig. 2, Fig. 3 shows another variant in which, compared to Fig. 2, the arrangements of source 9 and sensor 11 are switched.

In the case of the arrangement shown in Fig. 4, on the one hand source 9 empties into the interior of a container 1 via sealing connection 19 [and on the other] the input of sensor 11 is connected to the interior of container 1. The electronic analyzer shown in Fig. 1, to which sensor 11 is connected, is provided here as well. The embodiment shown in Fig. 1 or Fig. 4 is preferably used.

Fig. 5 shows, in the form of a block diagram, a preferred embodiment of analysis unit I that is partially outlined with dotted lines in Fig. 1. In the preferred embodiment, the output signal of sensor 11 is fed to a converter stage 21, which on the input side comprises an analog/digital converter 21a, which is immediately followed by an digital/analog converter 21b. Like the output signal of sensor 11, the output of digital/analog converter 21b is fed to a differential amplifier unit 23 that is

of a known design. The output of differential amplifier unit 23, corresponding to comparator unit 15 of Fig. 1, is connected to another amplifier stage 25, whose output is overlaid 28 on the input signal to amplifier 25 via a storage element 27.

Converter unit 21 and storage unit 27 are controlled via a timing signal generator 29. This arrangement works as follows:

To store value el_0 as shown in Fig. 1, from timing signal generator 29 a conversion cycle at converter unit 21 is enabled, at which point signal value el_0 appears at the input of differential amplifier unit 23. At essentially the same time, timing signal generator 29 preferably actuates storage unit 27, causing the output signal value of amplifier 25 to be fed back as a null-value-balance signal to the amplifier input. If when value el_0 was stored the output signal of amplifier 25 was not equal to zero, then this signal value is used as a null compensation signal via storage unit 27.

As indicated in reference to Fig. 1, the detection of major leaks can be done in different ways by, e.g, feeding the output signal value of converter unit 21 to another comparator (not shown), where said output signal value is compared to reference signal value ref as indicated in Fig. 1 or, as indicated by dotted lines at S_1, by switching the differential amplifier output, which is otherwise connected to sensor 11, to a reference potential, such as to ground, immediately before or after, and preferably after, storage unit 27 is set, and then on the output side of amplifier unit 25 directly testing the value of el_0 to

determine whether said value has reached the reference value as per ref of Fig. 1 or not.

Unlike what is indicated in the case of the preferred embodiments mentioned above, it is readily possible to omit the second converter stage, namely digital/analog converter 21b, and instead, as indicated at 22b by dotted lines, to provide an analog/digital converter and then subsequently to process both signals, i.e., el_o and el, digitally.

To check volume, either volume reference values are pre-entered at converter unit 21, provided, as indicated by dotted lines at ref_1, or another digital storage unit is connected to digital/analog converter 21b directly in order to convert input digital volume reference values into the corresponding analog signals and thus to use the arrangement shown to perform volume measurement as well.

The unit that is shown is exceptionally well suited for in-line testing of containers such as in a carrousel conveyor for, e.g., bottles, plastic bottles, etc.

In principle, it is also possible, after a predetermined test pressure is reached, to compare the electrical output signal of the sensor to this value or to several pre-entered values; this can be done on, e.g., a computer, where the sensor output is read in. The differential with respect to the set test pressure, i.e., the pressure drop, is determined by computer (compared to a boundary value entered into the computer or to a value that is determined from a reference leak).